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(54) **Drilling fluid**

(57) Water based drilling fluids comprise an aqueous medium, a polyalkylene glycol of formula $R^1O(CH_2 - CH(R) - O)_nH$, wherein R is hydrogen or methyl R¹ is hydrogen or alkyl of 1 - 10 carbons and n is 2 - 200, in amount of 0.5 - 60% by volume of the fluid, and an ester which is at least one of (i) the neutralisation product of an acidic phosphate ester, derived from a fatty alcohol or ethoxylated fatty alcohol, and (ii) a partial ester of a fatty acid, and a polyol with at least 2 hydroxyl groups. The fluid provides a high lubrication with high shale inhibition properties.

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DRILLING FLUID

This invention relates to water-based drilling fluids which are suitable for use in shale and clay formations.

A drilling fluid is used in conjunction with the rotary system of drilling. The drilling fluid is pumped from the surface
5 down the inside of the rotating drill string, discharged through ports in the bit and returned to the surface via the annular space between the drill string and hole.

The drilling fluid serves to cool and lubricate the bit and drill string, bring drill cuttings to the surface, consolidate the
10 side of the drilled hole, prevent squeezing-in or caving of the formation, control subsurface pressures, suspend drill cuttings when the column is static and minimise damage to any potential pay zone that might be encountered.

Drilling fluids generally contain a carrier, a weighting
15 agent and chemical additives. They are commonly divided into two categories, water based muds (WBM) and oil based muds (OBM). In the former the carrier is an aqueous medium and in the latter it is an oil. Diesel oil was used in the past as the oil, but more recently low toxicity drilling oils have been developed for this
20 purpose.

While WBM are more environmentally acceptable than OBM (since the latter still give rise to the problem of disposing of large quantities of oil contaminated drill cuttings, even if the oil is of low toxicity), they are recognised as being technically
25 inferior in a number of important areas such as thermal stability,

lubricity and shale inhibition.

Although shale is soft and therefore relatively easy to drill through, it still causes many problems for the drilling engineer. It disperses easily into the fluid, large lumps break
5 off and fall into the hole, pores in the shale can contain fluids trapped under pressure, and in extreme cases, the borehole wall may collapse.

Since shale makes up a high proportion of the rocks drilled in exploratory and production wells for oil and gas, particularly
10 in important producing areas such as the North Sea, it is important that drilling times and problems be kept to a minimum when drilling through such formations.

Many WBM formulations incorporating additives have been suggested in an attempt to control reactive shales and enhance the
15 lubricity of the fluid. Such additives include:

(a) salts such as potassium chloride to limit water uptake, reduce the swelling of the shale, and reduce leaching of any salt deposits encountered,

(b) chemically modified starch or cellulosic materials which
20 are used to reduce fluid loss,

(c) water soluble polyacrylamides or other water soluble polymers which adsorb on the surface of shale to bind it with a coating of polymer, thereby reducing dispersion of the shale,

(d) lime or gypsum which although sparingly soluble, act in a
25 similar manner to (a),

(e) asphaltene derived products such as gilsonite which assist in fluid loss control by acting as blocking agents for cracks and microfractures, and

(f) natural product oils of plant or animal origin to
30 improve the lubricity properties of the fluid.

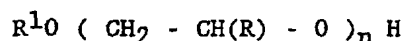
To date, however, none of these formulations has been able to provide shale inhibition or lubricity to the levels achieved with OBM.

This is because an OBM does not react with shale. A
35 conventional WBM will, however, react to a greater or lesser

extent with many shales causing them to swell and can give rise to problems such as stuck pipe, tight hole, overgauge hole, poor directional control, poor cementing and poor mud condition leading to extensive dumping and diluting and therefore high mud costs.

5 EP 495579 discloses a water based drilling fluid comprising

- (a) an aqueous medium,
- (b) a polyalkylene glycol of general formula:



10

wherein R is H or CH₃, R¹ is H or an alkyl group containing 1 to 4 carbon atoms and n is a number in the range 4 to 200, in amount 0.5 to 60%, preferably 1 to 20%, by volume of the fluid, and

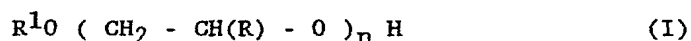
15 (c) a potassium salt, in amount 5-50, preferably 10-30 ppb (pounds per barrel), ie 14.3-143, preferably 28.6-85.7 g/l.

We have now discovered that the addition of certain esters results in an improved drilling fluid in which a synergistic effect between the glycol component which is the main shale inhibition component and the ester which is the main friction reducing compound affords a highly lubricating and inhibitive package for addition to whole mud systems.

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According to the present invention there is provided a water based drilling fluid comprising:

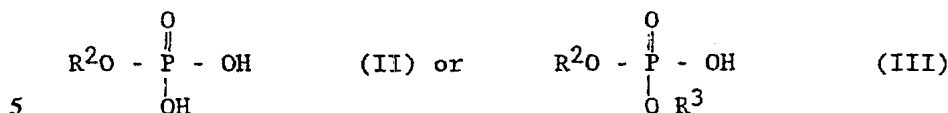
- 25 (a) an aqueous medium,
- (b) a polyalkylene glycol (or ether) of general formula:



30 wherein R is H or CH₃, R¹ is H or an alkyl group containing 1 to 10 carbon atoms and n is a number in the range 2 to 200e.g. 2-15 such as 2-10 or 3-8, in amount 0.5 to 60%, preferably 1 to 20%, by volume of the fluid, and

(c) an ester, which is at least one of (i) the
35 neutralisation product of an acidic phosphate ester of general

formula



wherein each of R^2 and R^3 , which are the same or different, is a radical derived from a fatty alcohol or an ethoxylated fatty alcohol, with an alkali metal hydroxide and (ii) a partial ester of a fatty acid and a polyol with at least 2 hydroxyl groups.

The invention also comprises a mixture of (b) and (c) for use in a water based drilling fluid of the invention.

The polyalkylene glycol or ether (b) is preferably water soluble, e.g. in an amount of at least 10g/l in deionized water at 25°C, and especially is soluble at 25°C in an amount of at least 10g/l in aqueous potassium chloride solution containing 70g/l KCl. The polyalkylene glycol (or ether) may but preferably does not exhibit a cloud point at 3% by weight in distilled water, below 80°C. The glycol or ether usually has an average molecular weight less than 1000 e.g. less than 700 especially 100-600 for polyethylene glycols and 200-450 for polypropylene glycols and 200-550 for copolymeric ethylene/propylene glycols, e.g. with 20-80: 80-20 ethylene oxy to propylene oxy units. The glycol may be tri propylene glycol, but is preferably a homo polyethylene glycol e.g. triethylene glycol, and tetra ethylene glycol, and polyethylene glycol mixtures of the above formula where R^1 and R are H and n is an average of 4-6. Hydroxy ethers with at least one hydroxyl and at least one ether group may also be used, especially monoalkyl ethers (alkyl preferably being of 1-10 carbons, e.g. 1-6 or 1-4 carbons such as methyl, ethyl or butyl) of the above glycols or polyols; examples are the mono butyl ethers of diethylene glycol and triethylene glycol or a polyethylene glycol of the above formula where R^1 is butyl and R is H and n is 2-7, usually with an average of 3. The hydroxy ethers are also preferably derived from homo polyethylene glycols.

In the phosphate ester c(i) of formula II or III, the or each group R^2 and R^3 , which may be the same or different, may represent a fatty aliphatic hydrocarbyl group e.g. of 8-30 such as 10-24 carbon atoms, which may be saturated i.e. alkyl or mono or polyunsaturated e.g. alkenyl or polyalkenyl with 2-4 olefinic groups. Examples of such groups are n-octyl, decyl, dodecyl, lauryl, palmityl, stearyl, behenyl and lignoceryl and linolyl, oleyl, linolenyl, ricinoyl and erucyl. Group R^2 or R^3 may also represent an ethylenoxylated derivative of said fatty group e.g. with 1-10 ethylene oxy groups such as a polyethylenoxy lauryl or polyoxyethylene (3) oleyl group. The phosphate ester may be of formula II or III or a mixture thereof such as one with 10:90 to 90:10 weight ratio of the two esters; such a mixture may be made by reaction of at least one molecule of formula R^2OH or a mixture of R^2OH and R^3OH with phosphorus pentoxide.

If the alkali metal hydroxide is soluble in the polyalkylene glycol of general formula (I) then the neutralisation product may be prepared by dissolving the acidic phosphate ester in the glycol and then adding the alkali metal hydroxide.

However, if the alkali metal hydroxide is not soluble in the polyalkylene glycol of general formula (I), then it can be dissolved in another polyalkylene glycol e.g. one of formula I wherein n is 1 or 2 or wherein n is 3 or 4 and R^1 is H, in which it is soluble and the neutralisation product may be prepared by dissolving the acidic phosphate ester in the glycol of formula (I) and adding the solution of the alkali metal hydroxide in the other glycol.

The ester c(ii) is a partial ester of a fatty acid and a polyol, said polyol having at least 2 hydroxyl groups especially at least 3 hydroxyl groups. The fatty acid is usually a monocarboxylic acid and is preferably of formula R^3CO_2H , wherein R^3 represents a fatty aliphatic hydrocarbyl group e.g. of 7-29 such as 9-23 carbon atoms especially an average of 13-23 carbons which may be saturated i.e. alkyl, or mono- or poly- unsaturated e.g. alkenyl or polyalkenyl with 2-4 olefinic groups. The fatty acid

usually has a straight aliphatic chain and may be a natural or synthetic acid. Examples of the fatty acid are n-octanoic, decanoic, dodecanoic, lauric, palmitic, stearic, behenic, lignoceric, octadecanoic, and oleic, linoleic, linolenic, ricinoleic and erucic acids. The polyol, which is preferably noncyclic, may be an aliphatic polyol e.g. with 3-10 carbons and 3-7 hydroxyl groups attached preferably to a hydrocarbonyl group, such as glycerol, trimethylolethane, trimethylol propane, pentaerythritol, 1,2,4 butane triol and 1,2,6-trihydroxyhexane.

The polyol may also be a ether polyol with 2-7 hydroxyls and 1-10 ether oxygen atoms, such as one of formula I wherein R^1 is H and n is 1-10; examples are di- and tri-ethylene glycol, diglycerol and glycerol bottoms may also be used. The polyol may also be a sugar alcohol, of 5-7 hydroxyls and 5-7 carbons, such as sorbitol, mannitol, or an anhydride thereof e.g. sorbitan.

The esters (ii) are partial esters and have at least one hydroxyl group e.g. 1-5 hydroxyl groups and at least one fatty acid group e.g. 1-3 and especially 1 or 2 such groups. The molar ratio of the number of hydroxyl groups (i.e. non esterified) in the partial ester to fatty acid groups in the partial ester is usually 0.4-6:1, preferably 0.7-5:1 especially 1-3:1. The hydrophilic lipophilic balance HLB value for the partial ester is usually less than 12, such as 1-12, but preferably less than 9 such as 1-6 especially 1.5-4. The partial ester is usually less soluble than the polyalkylene glycol (or ether) in water or in the aqueous KCl solution and may be water soluble in an amount of less than 10g/l e.g. 1-10g/l in deionised water at 25°C and especially soluble in an amount of less than 10g/g e.g. 1-10g/l in aqueous potassium chloride solution containing 70g/l KCl at 25°C.

The amount of the phosphate ester in the water based drilling fluid of the invention is usually 0.05-5% by volume e.g. 0.1-1% by volume and the relative volume of the polyalkylene glycol (or ether) (b) to phosphate ester c(i) is usually 1:1-20:1 e.g. 5:1-15:1. The amount of the carboxylic ester c(ii) in the water based drilling fluid of the invention is usually 0.1-10% by

weight e.g. 0.2-2% by weight and the relative volume of the polyalkylene glycol or ether (b) to carboxylic acid ester c(ii) is usually 0.5:1 to 15:1 e.g. 0.5:1 to 5:1 and preferably 1.5-4.5:1.

In the drilling fluid of the invention the polyalkylene glycol (or ether) and the ester, especially the carboxylic ester c(ii), form one liquid phase, and the resulting fluid too usually has one liquid phase, so is substantially free at 25°C of any dispersed liquid phase e.g. droplets of glycol (or ether) (b) or ester (c) or liquid hydrocarbon e.g. diesel oil or kerosene. The fluid is thus usually a solution not a dispersion or oil-in-water or water-in-oil emulsion. Hydrotropes are usually absent.

A potassium salt (d) is preferably present in the fluid of the invention and is usually in amount 5 to 50, preferably 10 to 30 ppb (pounds per barrel), ie, in amount 14.3 to 143, preferably 28.6 to 85.7 g/l.

The salt is preferably potassium chloride. However, other potassium salts such as formate, acetate, carbonate and phosphate are also suitable.

The fluid may also contain additional conventional ingredients such as weighting agents, eg barite, haematite or galena; viscosifiers, eg xanthan gum; fluid loss control agents, eg starch or cellulose derivatives e.g. carboxy methyl cellulose; shale inhibitors, eg polyacrylamide; and pH control agents, eg sodium or potassium hydroxide. The pH is suitably controlled to a value in the range 7 to 13. The amount of fluid loss additive, may be 0.5-15 ppb (pounds per barrel), e.g. 1-5 ppb, i.e. 1.43-42.9g/l, preferably 2.86-14.3g/l, or 5-15 ppb. The aqueous drilling fluids may also comprise a defoamer e.g. a silicone or aluminium based defoamer.

The aqueous medium may be fresh or salt water or brine or formation water.

The invention is illustrated with reference to the following Examples.

Example 1

Preparation of Combined Lubricant/Shale Inhibitor Package

Neutralising Solution

To 200g of a mixture of polyethylene glycols with an average
5 molecular weight of 194 and an average of 3-5 ethylene oxy groups,
30g of crushed potassium hydroxide was slowly added while stirring
vigorously and maintaining the temperature at 150°F (66°C). The
resulting solution was allowed to cool.

Preparation of Package A

10 To 100g of a mixture A of polyalkylene glycols which are
copolymers of ethylene oxide and propylene oxide in molar
proportion of 1:1 and average molecular weight of 500 which has a
cloud point in distilled water at less than 80°C, was added 10g of
a phosphated ester of polyoxyethylene (3) oleyl alcohol. With
15 vigorous stirring of this resulting mixture, 12g of the
neutralising solution was added until a pH of 7 was obtained to
afford a sample of Package A.

Preparation of Package B

The preparation was similar to the preparation of Package A
20 but used, instead of mixture A, a mixture B which was mono butyl
ethers of a mixture of polyethylene glycols with 2-7 ethylenoxy
groups and an average of 3, and an average molecular weight of
230. This ether mixture B was soluble at 25°C, both in water and
in aqueous KCl solution containing 70g/lKCl in amounts greater
25 than 10g/l. The ether mixture does not exhibit a cloud point at
3% by weight in distilled water below 80°C.

For maximum efficiency, Package A or Package B should be
added to whole mud systems at a level of 3% by volume.

Laboratory Evaluation of Lubricity and Shale Inhibition

30 The performances of Packages A and B were evaluated in
seawater in the presence of potassium chloride, potassium formate
and potassium acetate (and for the lubricity experiments, also in
the presence of xanthum gum to confer viscosity). Seawater and
potassium chloride form the typical 'base' fluid of a water based
35 mud system; however, alternative sources of potassium ions such as

potassium acetate and formate may be used.

Shale Inhibition and Lubricity

Procedure

- To evaluate the inhibitive properties of a fluid containing
 5 Package A or Package B, 3% (w/w ~10.5 ppb) was added to seawater
 and a known amount of dispersive London Clay (2-4mm fraction)
 added and the resulting mixture rolled at room temperature at 20
 rpm for 16 hours. At the end of this time the non dispersed clay
 fraction (>0.5mm) was recovered, dried, weighed and any
 10 correlation between shale inhibition and additive type noted.

For the purposes of determining lubricity, the standardised
 testing procedure "Procedure for Determination of Lubricity
 Coefficient" - American Petroleum Institute API RP 13B (1982) was
 used.

- 15 In these experiments, potassium chloride and other salts
 were added to the mixture and comparisons were carried out with
 mixtures A and B (without phosphate ester present).

Results

	<u>Fluid Composition</u>	<u>% Shale Recovery</u>	<u>Lubricity Coefficient</u>
20	SW	1	0.32
	SW/KCl	6	0.32
	SW/KCl/Mixture A	93	0.24
	SW/KCl/Mixture B	88	0.23
	SW/KCl/Package A	100	0.06
25	SW/KCl/Package B	98	0.07
	SW/KOAc	3	0.31
	SW/KOAc/Mixture A	90	0.28
	SW/KOAc/Mixture B	70	0.27
30	SW/KOAc/Package A	99	0.08
	SW/KOAc/Package B	97	0.07
	SW/KFormate	4	0.32
	SW/KFormate/Mixture A	89	0.28
	SW/KFormate/Mixture B	82	0.26
35	SW/KFormate/Package A	100	0.07

SW/KFormate/Package B 98

0.06

SW = seawater

- 5 * All potassium salts added at 10ppb.
 * Mixture A and B additives added at 8.8 ppb (2.5% wt/wt)
 * Package A and Package B additives added at 10.5 ppb (3% wt/wt)
 * Lubricity measurements - fluid comprises seawater, 1 ppb xanthan
 10 gum polymer to confer viscosity and additives at above
 concentrations.

Conclusion: The copresence of the mixture A or B with the
 phosphate ester enhances both the lubricity of the fluid and its
 shale inhibition properties.

Example 2

15 Procedure

To assess highly inhibitive fully formulated water based
 drilling fluid ("mud") systems, a more aggressive cuttings
 dispersion test was adopted. The test used approximately 100
 grams of London Clay or other suitable shale chips in the size
 20 range 4-8mm. The chips were placed inside a cylindrical drum
 whose curved surface comprised a 5mm brass or steel mesh. The
 drum containing the shale was partly immersed (to half the
 diameter of the drum) in the mud under test and the drum rotated
 for 4 hours. After this time the shale remaining was recovered,
 25 washed, dried and the amount of shale lost by dispersion into the
 fluid calculated. Examinations of the amounts of shale recovered
 in differing mud systems provide comparisons of the relative
 inhibitive nature of the mud systems under test.

Mud System

- 30 1 Seawater
 2 KCl - 25 ppb
 3 Xanthan gum - 1 ppb
 4 Drilling starch - 4 ppb
 5 Anionic polyacrylamide - 1 ppb

The components were added in the above numerical sequence
 35 with stirring on a Hamilton Beach mixer at high speed for 5

minutes following the addition of each component.

Results

	<u>Additive</u>	<u>% Recovery - Cuttings Dispersion Test</u>
	None	15
5	Mixture A	64
	Mixture B	57
	Package A	75
	Package B	72

Conclusion: The presence of the lubricity component enhances the
10 lubricity of the fluid and its shale inhibition properties.

Example 3

Procedure

To assess any effects that Package A or Package B might have
on the components in a whole mud system, a typical water based mud
15 system was made up as follows.

	<u>Mud System</u>	1 Seawater
		2 KCl - 25ppb
		3 Xanthan gum - 1 ppb
		4 Drilling starch - 4 ppb
20		5 Anionic polyacrylamide - 1 ppb
		6 Simulated drill solids - 30 ppb
		7 Baryte - 150 ppb

The components were added in the above numerical sequence
with stirring on a Hamilton Beach mixer at high speed for five
25 minutes following the addition of each component.

Using the above formulation as a base, samples containing
Package A and Package B were prepared (addition at 3% by volume)
and rheologies measured before hot rolling and after hot rolling.

* All rheological data measured at 120°F (49°C).

30 * Hot rolling test is at 150°F (66°C) for 16 hours in
Inconel stainless steel bombs.

	<u>Mud System</u>	<u>PV</u>	<u>YP</u>	<u>Gel</u>	<u>Fluid Loss</u>
	(Before Hot Rolling)				
	Base	25	29	12/14	6
35	Base + Package A	27	24	12/13	7.2

	Base + Package B	25	26	11/14	7.3
	(After Hot Rolling)				
	Base	23	26	10/12	8
	Base + Package A	22	24	11/12	7
5	Base + Package B	25	22	10/13	7.5
	Units: PV (Plastic Viscosity, cP); YP (Yield Point lb/100ft ²); Gel (10s/10m), Fluid Loss (ml)				
	<u>Conclusion:</u> The presence of Packages A and B does not affect rheological mud properties.				

10 Example 4

To 150g of the mixture B ethers used in Example 1 was added 50 g of a commercial partial ester of a fatty acid, as further described below. Solutions with one liquid phase at 25°C were formed and were stirred for 30 min. The partial esters were (X) glyceryl monooleate HLB 3.3 (sold as GMON/E by Croda), (Y) tetraethylene glycol monooleate), and (Z) glyceryl monoricinoleate HLB 3.6 (sold as GMR S/E by Croda) to give with the mixture B ethers as described above solutions designated packages X, Y and Z respectively.

20 The packages X and Y were tested for their activity in lubricity and shale inhibition in the same way as were tested packages A and B in Example 1.

The Results were as follows:

	FLUID COMPOSITION	% SHALE RECOVERY	LUBRICITY CO-EFFICIENT
25	SW	1	0.32
	SW/KCl	6	0.32
	SW/KCl/Mixture B	88	0.23
	SW/KCl/Package X	100	0.04
	SW/KCl/Package Y	98	0.11
30	SW/KCl/Package Z	100	0.04

Example 5

The process of Example 2 was repeated with the mud system of Example 2 and then addition of components as specified below.

35 Results:

<u>Additive</u>	<u>% Recovery - Cuttings Dispersion Test</u>
None	15
Mixture B	57
Package X	79

5 Example 6

The process of Example 3 was repeated with modified mud systems 1 and 2; system 1 comprised sea water, 25 ppb KCl 1.5 ppb xanthan gum, 4 ppb drilling starch and 0.5 ppb anionic polyacrylamide while system 2 contained in addition to system 1, also 40 ppb simulated drill solids and baryte up to Specific Gravity 1.3. Package X was added at 3% by volume separately to the system 1 and 2 and the rheologies of the aqueous drilling fluids obtained tested before and after hot rolling [200°F (93°C) for 16hr in Inconel Stainless Steel Bombs]. The tests were otherwise performed as in Example 3.

The results were as follows:

<u>MUD SYSTEM</u>	<u>PV</u>	<u>YP</u>	<u>GEL</u>	<u>FLUID LOSS</u>
Before hot rolling				
System I	10	21	7/11	---
20 System I + Package X	9	22	8/11	---
System II	20	38	17/23	4.2
System II + Package X	19	36	15/25	5.2
After hot rolling				
System I + Package X	13	16	10/13	---
25 System II + Package X	19	45	22/26	6.1

Units: PV (Plastic Viscosity, cP); YP (Yield Point, lb/100ft²); Gel (10s/10min); Fluid Loss (ml).

30 CONCLUSION: The presence of Package X does not adversely affect rheological mud properties.

Example 7

An aqueous drilling mud was made of the following components:

35 MUD COMPOSITION: Freshwater (0.867 bls), KCl (20ppb), KOH

(0.6ppb), xanthan gum (1ppb), drilling starch (2ppb), anionic polyacrylamide (1ppb) and baryte (187ppb) and variable amounts of Package X. The mud was not heat treated prior to use.

The water based mud systems were then tested for lubricity in apparatus representing a 1/4 scale simulation of the contact between a drillstring and pipe casing or formation core. The mud was evaluated under flow conditions (ca. 5 l/min) in a circulating system at 60°C. Package X was added to the mud at 1.5%, 3.0%, 4.5% and 6.0% (weight) in 10 minute intervals via shear mixing into the mud reservoir.

PIPE CASING: An N80 carbon manganese steel cylinder was used for the pipe casing specimen - 65mm long, 101.4mm in outer diameter and 50mm in internal diameter.

DRILL STRING: The drill string specimen was made of EN19T steel (0.4% C, 0.35% Mo, 1.0% Cr, 0.05% S). It was 40mm long and 31.5mm in diameter.

SIDE LOAD: A 150 N side load was applied during the testing.

Under the geometry of the apparatus this represented a typical side load of 260 lb/ft at a rotation speed of 400rpm (corresponds to 100rpm for full size drill pipe).

RESULTS:

Friction between pipe casing and drill string

	Amount of Package X	Reduction in friction
	(% by wt)	coefficient (%)
25	1.5	11
	3.0	32

There was no further reduction beyond 32% in the friction coefficient in drilling muds with 4.5% or 6.0% by weight of Package X.

30 Examples 8-11

Lubricity tests were performed on a number of drilling mud formulations made from sea water (200ml), xanthan gum (1ppb) and potassium hydroxide to pH10, then the ester as described below (1.5g) and finally the butyl glycol ether mixture used in Package B (4.5g). The test was performed as described in Example 1, but

the results are expressed in terms of the degree of reduction in the lubricity coefficient compared to the value without the ester and ether mixture. The results were as follows.

	<u>Example</u>	<u>Ester</u>	<u>HLB</u>	<u>Reduction in Lubricity Coeff.</u>
5	8	Glycerol Monooleate (Croda)	3.3	90%
	9	Sorbitan trioleate (Span 85)	1.8	80%
	10	Sorbitan monooleate (Span 80)	4.3	89%
	11	Sorbitan monolaurate (Span 20)	8.6	78%

Example 12

10 The tests for Examples 8-11 were performed with a
 formulation as in Example 8, but with the butyl glycol ether
 replaced by the same weight of mixture A polyalkylene glycols used
 in Example 1. These polyalkylene glycols are soluble at 25°C both
 in water and aqueous KCl solution containing 70g/l KCl in an
 15 amount of at least 10g/l; the polyalkylene glycols show a cloud
 point at 3% by weight in distilled water of less than 80°C. The %
 reduction in Lubricity Coefficient was 69%.

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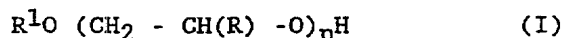
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Claims:

1. A water based drilling fluid comprising:

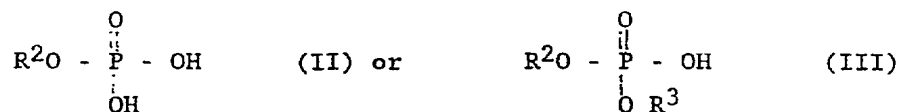
(a) an aqueous medium,

(b) a polyalkylene glycol (or ether) of general formula:



5 wherein R is H or CH₃, R¹ is H or an alkyl group containing 1 to 10 carbon atoms and n is a number in the range 2 to 200 in amount 0.5 to 60% by volume of the fluid, and

(c) an ester, which is at least one of (i) the neutralisation product of an acidic phosphate ester of general
10 formula



15

wherein each of R² and R³, which are the same or different, is a radical derived from a fatty alcohol or an ethoxylated fatty alcohol, with an alkali metal hydroxide and (ii) a partial ester of a fatty acid and a polyol with at least 2 hydroxyl groups.

20 2. A fluid according to claim 1 which is one liquid phase at 25°C.

3. A fluid according to claim 1 or 2 wherein the glycol or ether (b) is water soluble and has an average molecular weight of less than 700.

25 4. A fluid according to claim 3 wherein the glycol or ether (b)

is a copolymeric ethylene glycol/propylene glycol or an alkyl ether of a polyethylene glycol.

5. A fluid according to any one of the preceding claims, wherein the ester (c)(ii) is a partial ester with a polyol with at least 3 hydroxyl groups.
6. A fluid according to any one of the preceding claims, wherein the ester (c)(ii) is a partial ester of a straight chain fatty mono carboxylic acid of 9-23 carbon atoms said ester having a hydrophilic lipophilic balance of 1-6.
7. A fluid according to any one of the preceding claims, which also comprises a potassium salt.
8. A mixture of a polyalkylene glycol or ether (b) and ester (c), each as defined in any one of the preceding claims.
9. A method of drilling involving pumping a drilling fluid from the surface down inside a rotating drill string, discharging said fluid through ports in the bit and returning said fluid to the surface via the annular space between the drill string and hole, in which the drilling fluid is as claimed in any one of claims 1-7.
10. Use of a mixture of a polyalkylene glycol or ether (b) and ester (c) as claimed in claim 8 for lubrication and shale inhibition in an aqueous drilling fluid.

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Patents Act 1977
Examiner's report to the Comptroller under Section 17
(The Search report)

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Databases (see below)

(i) UK Patent Office collections of GB, EP, WO and US patent specifications.

(ii) ONLINE WORLD PATENTS INDEX

Documents considered relevant following a search in respect of Claims :-
1 TO 10

Categories of documents

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Category	Identity of document and relevant passages	Relevant to claim(s)
A	EP 0495579 A (B.P)	1, 8 & 9

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